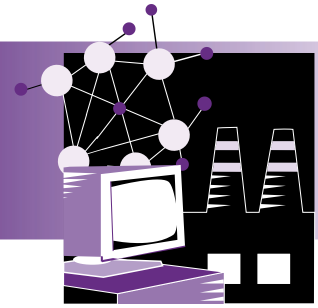
INDUSTRIAL MATERIALS FOR THE FUTURE

Project Fact Sheet



Fabrication and Testing of a Prototype Ceramic Furnace Coil for Chemical and Petrochemical Processing

New process produces ethylene more efficiently

To create ethylene, ethane is combined with steam and passed through a coil placed in a high-temperature furnace. The higher the coil temperature, the greater the amount of ethylene that can be produced during the process.

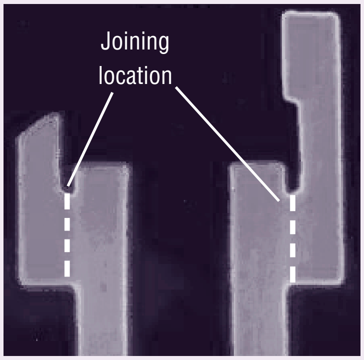
Conventional metal furnace coils used in this process are hampered by temperature limitations and require frequent maintenance to remove coke that builds up inside the tubes during processing. These metal furnace tubes require replacement approximately every 1 to 2 years. Silicon carbide (SiC) ceramic tubes, which last 2 to 3 times longer than metal-alloy tubes, have been developed to limit coil replacement. These tubes allow chemicals to be processed at significantly higher temperatures than traditional metal-alloy coils, improving the energy efficiency and yield of the petrochemical process. Due to the relative inertness of SiC compared to metals such as nickel (Ni) and chromium (Cr), SiC tubes have been demonstrated to have very low levels of coke deposition.

However, producing ceramic tubes long enough to be used in furnaces has been a challenge. Commercial vendors produce SiC ceramic tubes no longer than 15 to 20 feet, while the minimum length of furnace coils is 30 to 40 feet. FM Technologies, Inc. (FMT) has responded to this challenge by developing a process that uses microwave and radiant heating technologies to join pairs of SiC ceramic tubes to create longer furnace coils. Early results of this new technology have attracted considerable interest from an industry that recognizes the value of increased temperatures on product yields.

Sintered SiC Tubes

Source: FM Technologies

Microwave-joined sintered SiC tubes



Tube failure other than at the joint when excessive loading was applied

Using microwave and radiant heating technologies, FM Technologies' sinters pairs of SiC ceramic tubes into furnace coils that can be used in the more efficient production of ethylene.

Benefits

- Addresses key issues in both the Petroleum Roadmap (listed as new structural materials to decrease the cost of maintenance in Chapter Two, reduce fouling and energy by 10 percent over existing technologies in Chapter Three) and the Chemical Materials of Construction Roadmap (listed as critical problem area in Exhibit 4-1)
- Potential to save 6.39 trillion Btu per year gas-equivalent based on a 10 percent increase in efficiency when converting ethane to ethylene at higher temperatures
- Could reduce CO_2 emissions by up to 465,000 tons per year based on energy savings of 6.39 trillion Btu per year
- Increases service temperatures of furnace coils from 1000°C to a range of 1200 to 1400°C
- Reduces catalytic coke formation associated with use of metal coils created from nickel and chromium, resulting in fewer productivity losses from shutdowns for coil cleaning
- Increases ethylene yields by using higher temperatures and shorter residence times

Applications

This new technology will have immediate applications in the petrochemical industry. The silicon carbide (SiC) ceramic tubing is designed to replace metal-alloy tubing and provide more efficient production of chemicals, especially ethylene.

Project Description

Goal: Use microwave joining technology to fabricate and test a prototype subscale ceramic furnace coil that is longer than the microwave cavity used to accomplish the joining.

SiC ceramic tubes can be operated at 1200 to 1400°C. Metal coils, in contrast, are not operated above 1000°C due to high temperature yield limitations. Higher coil temperatures result in more efficient reactions by up to 10 percent with a resulting reduction in byproducts.

Coke build-up on conventional metal furnace coils is an undesirable byproduct of ethylene production, as well as a major maintenance problem. Periodic maintenance shutdowns are required to clean coke from metal furnace coils. This cleaning process, which involves high-pressure steam, can lead to damage and premature replacement of metal tubes. The use of SiC tubes in test furnaces has been proven to mitigate coke formation.

FM Technologies, Inc., is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Design and fabricate a microwave cavity that will be used to join SiC tubes to create a prototype ceramic furnace coil.
- Fabricate prototype ceramic furnace coils.
- Test the prototype coils to failure in tension and report on testing results.

Economics and Commercial Potential

According to Chemical Market Reporter, ethylene is one of the highest production chemical commodities in the world, accounting for approximately 85 million metric tons in 1998 and a predicted volume of 136 million metric tons by 2010. Westaim Corporation, a leader in furnace-coil technology, states that ethylene producers currently consume $400 million per year in tubular products worldwide and are projected to consume $600 million per year by 2005. Typically, this market reflects 80 percent for maintenance or re-tubing and 20 percent for new installations.

In addition, petrochemical production is near peak capacity. A number of ethylene plants are being built to deal with this high capacity use. This expansion provides a window of opportunity for the introduction of new, more efficient technologies.

FMT's new technology provides an opportunity for increased efficiency not possible with current metal furnace coils. The reduction of coking on furnace coils is expected to reduce required shutdown times and cleaning of the tubing and increase efficiency of the production facility. In addition, increased temperature tolerances will increase reaction rates, enhance yields, and decrease byproducts of the reactions. These factors should improve the overall efficiency of the cracking process and encourage ethylene producers to incorporate this new technology into these new plants.

Industrial Materials for the Future

The Industrial Materials for the Future Program focuses on the development and commercialization of new or improved materials that enhance productivity, product quality, and energy efficiency in the major process industries. These materials resist high-temperature fatigue, corrosion, and wear. Research focuses on metallic and intermetallic alloys, structural polymers and membrane materials, and materials processing methods.

The OIT Industrial Materials Leader: Charles A. Sorrell (202) 586-1514.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

For project information, contact:

Dr. Ernest Zaidman
FM Technologies, Inc.
10529-B Braddock Road
Fairfax, VA 22032-2236
Lab Phone: (703) 941-0495 ext. 104
Phone: (703) 425-5111
Fax: (703) 425-3539 or
(703) 941-3624
ezaidman@fm-technologies.com
Home Page:
www.fm-technologies.com

For program information, contact:

Lisa Barnett
Program Manager
Inventions & Innovation Program
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

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Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

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